SECTION 5. WATERSHED MANAGEMENT RECOMMENDATIONS FOR WATTS BRANCH

A suite of stormwater retrofit and stream rehabilitation sites have been identified and prioritized for implementation in the Watts Branch watershed, as detailed in Sections 3 and 4, respectively. In this section, specific management recommendations are presented that target the watershed as a whole by recommending priorities for project implementation on a subwatershed basis.

It was previously established that, due to the existing conditions of the Watts Branch watershed, it falls under the "impacted" to "non-supporting" stream classification and that management approaches and expectations should be consistent with this designation. However, it is also important to establish some ambitious goals for rehabilitation as a component of an effective and successful management plan for an "impacted stream." The specific Watts Branch watershed protection goals (see Section 1.1) were developed with this in mind, and the management strategy presented in this Section strives to achieve the goals.

As past research and discussion has revealed, there are several watershed management tools available to help restore an "impacted" or "non-supporting" watershed. Some of the tools are "structural" practices that involve physical watershed control measures. Other tools are "nonstructural" practices that include citizen behavior modification to encourage pollution prevention, watershed stewardship education, reforestation, and aquatic buffer enhancement. An effective watershed plan should have a balance of both structural and nonstructural approaches to help achieve the goals, because it is unlikely to expect to realize these goals with a structural approach alone.

5.1 Watershed Assessment

In formulating a watershed management plan, it is necessary to review the findings of the analyses that have been conducted in an inclusive and integrated manner, so that consideration is given to a broad array of factors. For example, the Phase I work consisted of the stream channel assessment work, which contained four major elements: the stream channel enlargement analysis, the rapid geomorphic assessment (RGA), the rapid stream assessment technique (RSAT) and hydrologic modeling. Each of these elements contributes complementary data that help produce converging lines of evidence to form a foundation for developing the watershed plan.

As reviewed in Section 2.1, the stream channel enlargement assessment methodology yielded data on the amount of channel enlargement that has occurred over the last 35 to 40 years at ten distinct sampling stations in the watershed. In addition, the amount of current and historic impervious cover was estimated. The general conclusion from these studies is that the stream channels of Watts Branch have enlarged by as much as 100% since the early 1960's when land development started to become the dominant activity in the watershed. The more compelling finding, however, is that channel enlargement is continuing and is predicted to reach as much as four to six times the original cross-sectional area before reaching a state of quasi-equilibrium. The other important factor is the expected time frame for the channel to reach this condition. Based on the current average age of development and the time frame for alluvial channels to reach a more balanced condition, another 40 to 50 years of channel adjustment is expected.

These results have import influence in developing watershed management strategies. The most obvious is to recognize that the hydrologic characteristics have been altered sufficiently throughout the watershed to create conditions where channel enlargement is likely to continue. Knowing that this underlying tendency exists can help in making some specific management recommendations. Four key recommendations include:

- Since Watts Branch is only partially along in the channel evolutionary process, an extraordinary effort is warranted to provide as much stormwater management channel protection as possible.
- Recognizing that current and future development contributes to channel enlargement, future development (e.g., the Fallsgrove project) should be designed to maximize channel protection capability.
- Stream channel stabilization techniques will need to accommodate the physical characteristics tending towards future channel enlargement. In some cases stream rehabilitation strategies may need to "hard line" the channel to protect property, utility lines, trees, or other infrastructure, and in other areas, rehabilitation may utilize "softer" techniques that can adjust as channels tend towards a larger cross-section.
- Stormwater retrofit and stream channel stabilization projects should be linked where a downstream channel stabilization project will benefit from upstream retrofit projects where altered hydrology can be at least partially remediated.

The RGA data provide supporting or complementary evidence to help validate the enlargement data. All ten sampling stations are currently rated as either "in transition" or "in adjustment." This one-time "snap-shot" assessment confirms that Watts Branch stream channels are currently enlarging. The data suggest that widening is occurring at all ten sampling locations and there is about an equal split between sites experiencing aggradation and degradation. This seems to confirm the imbalance in hydrologic forces and sediment load (see Appendix A for a complete discussion of the channel enlargement theory).

The RSAT results also support the enlargement data. With very few exceptions, all sampling stations rated as either "good" or "fair" conditions, suggesting an identified impairment, but not yet so impaired as to impede all uses. Out of a total of 132 RSAT stations, 62 locations were identified as needing further investigation for possible stream rehabilitation.

As part of Phase I, hydrologic modeling was also performed to help confirm the hydrologic indicators from the channel enlargement investigation and to document the flow rates for a range of storms in various locations throughout the watershed (see Section 2.3). Another element of the hydrologic modeling is to show the effects of existing structures on peak flow rates and to provide a baseline to help assess the benefits of proposed retrofit structures. These data are the most useful in estimating the level of hydrologic control for the channel forming storm events (i.e., six month through 18 month events) throughout the watershed. The benefits of the proposed retrofits can be compared to "pre-developed" and "existing" flow rates to get a sense of the amount of channel protection control being provided.

As discussed in Section 1, the watershed has a current impervious cover of approximately 28% which is right in the range between an "impacted" and "non-supporting" stream. Since ample

evidence exists that the watershed is impaired, but still rates at least a "fair" designation, the implementation of watershed rehabilitation measures will go a long way towards maintaining a viable water resource. In short, the watershed assessment stage of the project concluded that Watts Branch is very much a "restorable" watershed.

5.2 Structural Watershed Rehabilitation Using a Subwatershed Management Strategy

As described in Section 3, 54 candidate stormwater retrofits sites were originally identified (using available watershed mapping resources) and field investigated to verify technical feasibility and to identify the most likely management practice for each site (Appendix E contains the completed retrofit inventory form for each of the 54 candidate sites). Seventeen of the 54 candidate sites were abandoned after the field screening for a variety of reasons (again, see Appendix E). The remaining 37 sites were evaluated through a ranking process that involved the development of several alternative ranking techniques, a sensitivity analysis, and participation from the Watts Branch Partnership to arrive at a short list of projects to carry forward to Phase II. The process identified 18 candidate sites for further investigation through the development of detailed conceptual designs. Upon completion and presentation of the 18 concept designs to the Partnership, public, and regulatory agencies, three of these sites were removed from consideration. One site, SM-8 (Aintree Pond), is being improved at this time outside the watershed study process. This results in 14 sites as priority implementation projects for the watershed study.

As discussed in Section 4, 62 RSAT locations were identified as candidates for stream rehabilitation. The stream rehabilitation identification process combined RSAT sampling sites into a single stream rehabilitation reach where adjacent RSAT sampling sites indicated a need for stream channel rehabilitation and resulted in 35 separate stream rehabilitation project sites (see Table 4.4). Candidate stream rehabilitation sites were ranked based on a ranking system developed by ESA, the Center, City staff, and the Watts Branch Partnership. The City staff, ESA, and the Watts Branch Partnership agreed to carry forward sites in two categories; a first tier consisting of the top 11 sites and a second tier for the remaining sites. By combining multiple adjacent sites, nine distinct stream project areas went forward to the design concept stage.

Figure 5.1 illustrates the locations of the top 14 retrofit sites (SM-8 is also shown on the figure) and top nine stream rehabilitation sites still under consideration after concept review. This figure also illustrates 10 subwatersheds and where each project is located in the context of a subwatershed management strategy. While all 14 retrofit and nine stream rehabilitation sites are valid candidates for further investigation and design, the reality is that fiscal and staff resources limit the number of projects that can be implemented in a timely fashion. In addition, it is most appropriate to implement projects that complement each other and limit the overall disturbance of exiting natural resources as much as possible. It is therefore important to try to prioritize the implementation of these projects in a subwatershed context. In other words, sites that should be pursued first should be pursued in the context of the overall benefit to the watershed through a subwatershed management strategy and an approach that seeks to combine stormwater retrofits with other rehabilitation strategies.

Three parameters were evaluated to identify subwatersheds for high priority implementation: the current condition of riparian buffer within each subwatershed, the distribution of stormwater retrofits across the watershed as a whole, and the relative proximity of recommended stream rehabilitation sites downstream from recommended retrofit sites. Table 5.1 lists the subwatersheds recommended for priority implementation. Figure 5.1 shows the locations of the prioritized subwatersheds. It should be noted that there are additional considerations that may ultimately shift the priority implementation such as the efficiency of coordinating with other public works projects (e.g., sewer repairs and improvements), community issues and concerns (e.g., severe erosion correction and/or park program considerations), and wetland and forest area improvements. A brief discussion of each of the priority subwatersheds is provided below.

Subwatershed 204, while having among the best current riparian cover, contains three important stormwater retrofit sites (SM-18, SM-19, and SM-20) with the capability to substantially control a significant portion of the runoff from the contributing subwatershed. These three sites coupled with implementation of stormwater management on the King Farm, are upstream from three of the recommended stream rehabilitation sites (site 204-5, 204-1, and 302-12, downstream from SM-18, SM-19, & SM-20). Subwatershed 205 also has excellent riparian cover and has upstream stormwater management provided on the King Farm. Consequently, it is recommended to pursue stream rehabilitation sites 205-5 to 205-8, 205-1 to 205-2 and site 302-12 (this site is downstream to subwatershed 204 and 205).

Subwatershed 114 is the most impervious subwatershed in the study and it contains virtually no stormwater management controls (neither water quantity nor water quality control). Retrofit site SM-23 provides an opportunity to control and treat a portion of the runoff from this subwatershed, which will also benefit priority downstream rehabilitation sites. Site SM-22 is also in subwatershed 114 and, while located within a private office park, has the potential to contribute significant hydrologic controls. Finally, there is a direct link in subwatershed 115A where site O-3 is above the pipe leading to the stream rehabilitation site 115A-1 to 115A-3. Just below and above the confluence with the Watts Branch mainstem (tributary 302) is another stream rehabilitation site (302-3, 4 & 6). When combined with the upstream retrofit project and the stream rehabilitation work in subwatersheds 115A and 114, it makes sense to consolidate the construction in this area. In addition, stream rehabilitation site 302-3 to 302-6 will receive some benefits from upstream retrofit sites in subwatersheds 204, 205, and 115.

Subwatershed 119 is an opportunity to provide both water quality and channel protection storage for almost the entire subwatershed. While there are no stream rehabilitation sites associated with this priority subwatershed, it will nevertheless provide a benefit to downstream conditions.

Subwatershed 103 contains the retrofit sites SD-8 and SD-6, and two stream rehabilitation segments (sites 103-1 to 103-2; and 103-5 to 103-8). Based on the amount of existing stream channel degradation, the potential for at least partial control of channel forming storm events, and the potential for riparian buffer enhancement, it is our recommendation that subwatershed 103 be carried forward as a priority site.

Woottons Mill Park is experiencing significant erosion along the mainstem of Watts Branch, and has extensive stream rehabilitation proposed. Stream protection is vital along these reaches because of

the large volume of runoff from many neighborhoods that have no SWM opportunities. The City's Watts Branch sanitary sewer trunk line, which parallels the mainstem, has been exposed in several locations. The Department of Public Works intends to stabilize these eroded reaches and repair the sewer manholes and lines before more serious damage occurs to the sewer line. Therefore, the stream rehabilitation projects from 401-8 to 401-11 and 401-15 to 401-18 are also listed as priority in the City's Implementation Schedule, although they are not part of a particular subwatershed.

Table 5.1 Recommended Subwatershed for Priority Implementation

Subwatershed Designation	Recommended Projects for Implementation	Justification
204	Stormwater retrofits: SM-18, SM-19 & SM-20 Stream rehabilitation sites: 204-5; and 302-12 to 204-1[1]	combines retrofits with downstream stream rehabilitation, and consolidates construction disturbances
205	Stream rehabilitation sites: 205-5 to 205-8; & 302-12, 205-1 to 205-2[2]	combines upstream stormwater management (King Farm) with downstream stream rehabilitation, and consolidates construction disturbances
114 & 115A	Stormwater retrofits: O-3, SM-23 and SM-22* Stream rehabilitation sites: 115A-1 to 115A-3; & 302-3, 302-4 to 302-8[3]	combines retrofits with downstream stream rehabilitation, and consolidates construction disturbances
119	Stormwater retrofits: SM-1, SM-2, and SM-3	downstream retrofits that provide water quality and channel protection treatment for the majority of the subwatershed
103	Stormwater retrofits: SD-8 and SD-6 Stream rehabilitation sites: 103-5 to 103-8; & 103-1 to 103-2[4] Riparian buffer enhancement	combines retrofits with downstream stream rehabilitation, buffer enhancement, and consolidates construction disturbances
Mainstem	Stream rehabilitation sites: 401-15 to 401-18, 401-8 to 401-11, 401-3 to 401-3, 401-5 to 401-6	combines upstream retrofits with stream rehabilitation to stem significant erosion and protect City sewer infrastructure

Notes:

* It is acknowledged that site SM-22 is privately owned. The City should work diligently with the owner to pursue this project.

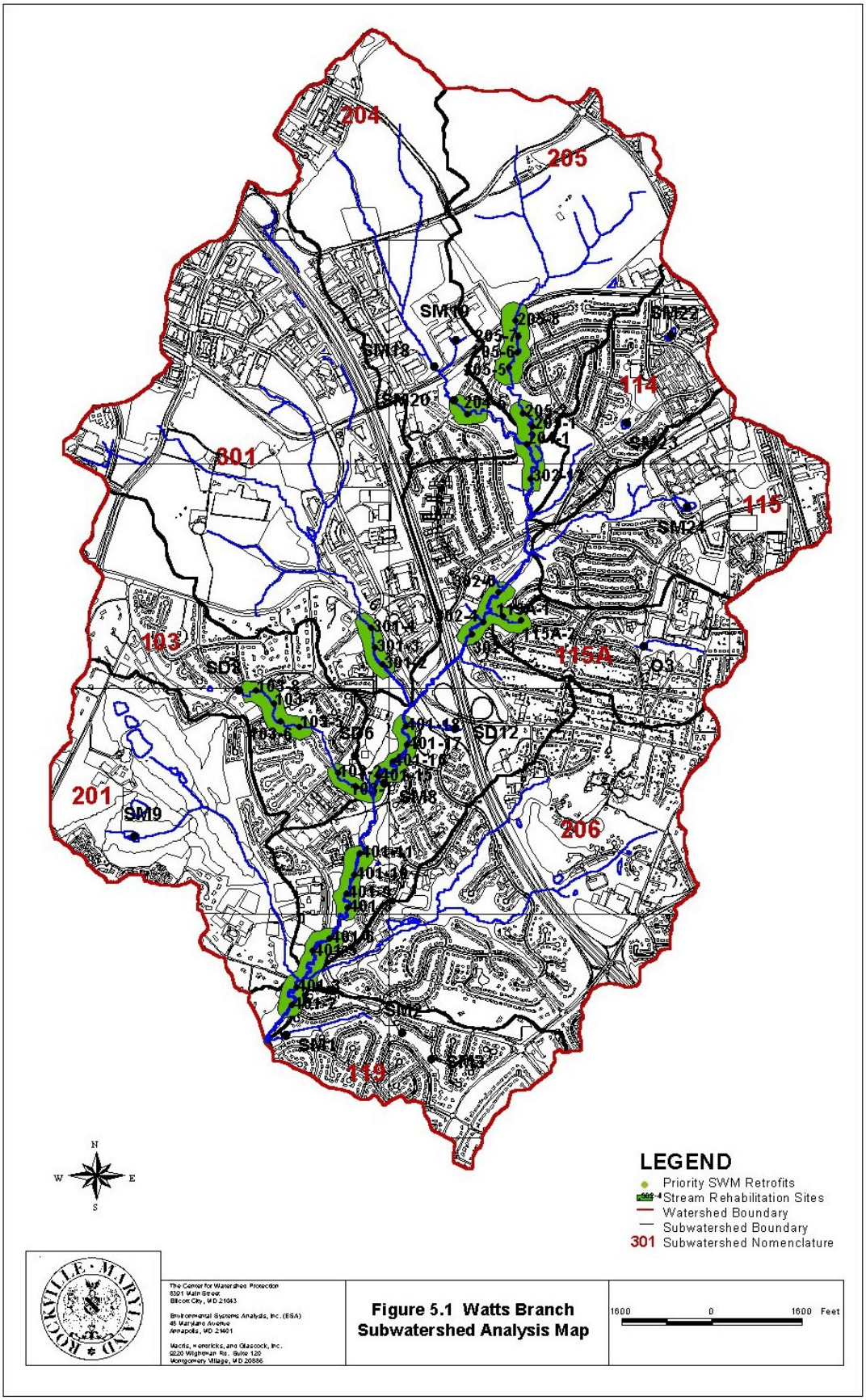
Option 1 Stream rehab. for site 204-1 would be combined with SM-20 to minimize construction disruptions

Option 2 Stream rehab. for site 205-1 & 205-2 combined as one reach with sites 302-12 to 204-1

Option 3 Stream rehab. for site 115A-1 to 115A-3 combined as one site with 302-3 to 302-6 to link disturbed areas and minimize construction disruptions

Option 4 Stream rehab. at site 103-1 & 103-2 would also include sites 401-15 to 401-18 to link disturbed areas and minimize construction disruptions

Figure 5.1Subwatershed Analysis Map



5.3 General Recommendations for Implementation

In addition to these specific subwatershed recommendations, the City and Center have developed the following general recommendations and guidelines to be aware of throughout the stormwater retrofit and stream rehabilitation implementation process.

- The SWM and stream restoration concepts offer guidance for final design. They represent staff's and the consultant's best recommendations at this time for overall watershed improvements. However, the concept designs are intended to be flexible, and will be re-evaluated at final design if SWM design standards or techniques have advanced. Further, staff will also consider revising SWM projects to take advantage of alternate locations or layouts if better opportunities present themselves, such as replacing a portion of a SWM pond on park land with an equivalent facility on available private land. Any revisions which substantially change a SWM or stream restoration project will be discussed with the staff team and the community.

- At the beginning of the Final Design phase, the City should schedule coordination meetings with representatives from the wetland/waterway regulatory agencies, including Maryland Department of Environment, the Army Corps of Engineers, and Maryland Department of Natural Resources, and any dam review agency, such as the Natural Resources Conservation Service, to obtain direction on permitting issues. All comments under individual projects regarding state/federal permitting issues reflect the wetland/waterway disturbance regulations as of 2000. These regulations and design criteria are subject to change. Projects must meet the regulations in effect at the time of the actual permit request.

- A City staff team, including the City Forester, the City Environmental Specialist, the Department of Recreation and Parks (R&P), the Neighborhood Resource Coordinators and the Project Implementation Coordinator, should meet as needed to ensure close coordination between departments and to develop plans for appropriate communication with the public.

- In keeping with DPW practice, local Homeowners'/Civic Associations, nearby residents and other interested parties such as Watts Branch Partnership members should be notified at the beginning of the Final Design stage and invited to comment on final design plans. Certain projects will need more formal or intensive community consultation to set priorities and resolve design issues as early as possible. Where necessary, the City will form a volunteer advisory group at the beginning of the Final Design stage to collect community feedback; interested residents and homeowners/civic associations should participate in this group to have their opinions considered.

- All sites will require a Natural Resource Inventory/Forest Stand Delineation and Forest Conservation Plan that comply with the requirements of the ordinance, including all revisions to the ordinance at the time the site is reviewed by the Development Review Committee.

- Most projects are expected to require 3:1 reforestation and significant tree replacement. Where possible, Forest Conservation Plan requirements shall be met on-site; if this is not feasible, they shall be met as close to the site as possible.

- 2 ½-3" caliper trees should be used as necessary to achieve a more mature appearance to reforestation areas.

- Since public acceptance of watershed improvements will, in part, depend on the attractiveness of the constructed SWM and stream projects, the City should plan for appropriate plantings, tree preservation and trash removal to maintain the performance and the setting of these projects. For example, high-quality, site-appropriate landscaping should be used and more frequent trash removal should be planned for SWM projects in high visibility areas or active parks.

- The SWM designs should emphasize aesthetic appeal wherever possible. Each site should be considered individually within the context of its surroundings. SWM ponds in wooded settings or in areas of heavy deer grazing may be more successful with a natural, wild appearance, whereas more formal landscaping may be appropriate for highly visible parks. At time of final design for ponds in highly visible areas, staff should investigate techniques to soften the riser and inflow structures, such as concrete tinting, facing and vegetative screening.

- DPW and R&P should start the process of developing cooperative maintenance and wildlife management plans for SWM sites located on City parkland. Cooperative management plans should be developed for all future SWM sites prior to construction.

- Safety fences are intended only to prevent very young children from gaining access to permanent pool areas, and are no substitute for appropriate adult supervision. Generally, fences are not advisable for online (i.e., in-stream) ponds because they may collect trash that could block the stream's baseflow. All SWM facilities will be designed with standard safety features, such as 3:1 slopes and safety benches at the permanent pool edge. Therefore, the City does not typically fence SWM facilities unless the community expresses a desire for this feature. Fences are typically chain link or split rail with attached wire fencing. The issue of safety fences around each pond should be discussed with the community at the time of final design.

- The City strives to balance SWM needs for developed areas against environmental and community impacts by placing new SWM facilities in locations with the least disturbance to natural resources, recreation features and active park usage areas, and to upgrade older SWM facilities. It is the City's policy to attempt to locate SWM on private property wherever possible so as to limit the impact of SWM facilities on City park space.

- Where practical, the City may recommend either retrofits of existing private SWM facilities or construction of new public SWM facilities on private land to provide regional SWM. These private sites will be recommended for regional SWM on a case-by-case basis, considering factors such as cost of the SWM facility itself, any land/easement purchases, site constraints, effectiveness of this and other local facilities in the sub-watershed, cooperation of the property owner and comments from nearby residents. In some circumstances, DPW

may seek to use a private SWM facility as part of a series in the sub-watershed to reduce the size or need for SWM facilities on active park land or in high-priority natural resource areas.

- Funding for projects on private property will not necessarily be provided by the City. The Department of Public Works will work with private property owners as necessary to explore alternate funding opportunities, to cost-share or to coordinate improvements as part of the private development process. However, the City may implement a public SWM utility fee in the future to help fund land acquisition and/or regional SWM improvements on private property.

- The SWM concepts show conservative limits of disturbance to accommodate construction, staging and adjacent tree impacts. However, final limits of disturbance and tree removal are not decided until the final design and construction stage. The limit of disturbance may be smaller or slightly larger than shown in the concept. Some SWM concept sites were designed using detailed (2' contour interval) topography due to a concurrent topographic survey by R&P in some parks. Those designed with less detailed information (5' contour interval topography), including SM9, SM18, SM19, SM20, SM22, SM24, SD8, SD12, SD24 and O3, will need adjustments to conceptual grading and to the limits of disturbance to reflect more accurate information. The City Forester's staff will work with DPW to preserve as many trees as possible.

- Consider offering monetary incentives to contractors to save additional trees within the limit of disturbance during the construction phase. The intent would be to decrease the actual number of trees removed during construction within the expected clearing shown in final design plans. The City Forester would determine whether the trees have been adequately protected.

- The bio-engineering methods shown in the restoration concepts emphasize erosion control and aquatic habitat enhancement. Bio-engineering techniques may change in the course of project implementation and the City will incorporate other appropriate techniques in the final design plans as advisable. Similarly, should SWM design criteria evolve during the implementation phase, SWM concept details may be slightly altered, such as riser design or improvements to safety features. Any substantial changes to appearance shall be discussed with the community during the final design stage.

- The City should follow a performance monitoring plan for the watershed to evaluate gains over a ten to fifteen-year period. The performance indicators discussed in a later section of this report will help the staff determine whether the projects are meeting watershed management goals.

5.4 Watershed Education and Pollution Prevention Strategy

While the structural practices are an important component of the success of the Watts Branch Watershed Management Plan, an equally important component is a commitment to watershed education and pollution prevention strategies. This is particularly true in largely built-out watersheds such as Watts Branch, where opportunities for meaningful structural controls are limited and costly.

It has been a long standing tenet of stormwater treatment that it is more cost effective to prevent or minimize pollution at the source than to treat it once it is in the drainage and receiving water system. With any watershed restoration effort, the involvement of those that live and work in the watershed is vital to ensure long term success. Many people may be unaware of the impact of their actions on stream quality and aquatic habitats, and might be willing to make changes to those behaviors if they better understand the relationship between their individual behaviors and the water quality of the watershed they live in. By learning to eliminate actions that can produce non-point source pollution, concerned citizens can reduce the overall impacts of polluted stormwater runoff while creating a sense of partnership in the success of the watershed restoration plan.

The primary goal of the Watts Branch pollution prevention program is to alter current behaviors that contribute to pollutant loading within the watershed and assist in accomplishing the overall goals of the watershed restoration plan. The program will also benefit larger city-wide pollution prevention efforts. The use of public outreach and pollution prevention education efforts will allow those charged with implementing the watershed restoration plan to directly meet a number of the identified watershed protection goals for Watts Branch. Specific goals that can be targeted, in part, with a pollution prevention program include:

- Increase and expand local awareness both in and beyond the Watts Branch watershed.
- Reduce pollutant loads to Watts Branch, the Potomac River, and the Chesapeake Bay

In addition, public outreach can indirectly assist in meeting two additional goals of the plan.

- Protect riparian buffer, forest, and wetland zones
- Reduce stream channel erosion, and improve stream habitat

Advantages to incorporating these nonstructural stormwater practices into the Watts Branch Watershed Management Plan include:

- They are relatively inexpensive to implement in relation to structural stormwater practices.
- Some of the suggested practices only require behavior modification to ensure they result in less pollution runoff. In some of the more densely developed portions of the watershed, alterations in citizen behavior may be the best way to realize pollutant reduction targets.
- They encourage citizen and business involvement in the Watts Branch watershed restoration process, and foster a sense of ownership of the local watershed.
- For some of the recommended practices, organizations that can assist in outreach efforts are already present in the watershed (e.g., Watts Branch Partnership, HOAs).

5.4.1 Program Recommendations

Table 5.2 presents program recommendations for the City to consider. Pollution prevention program success starts with educating the public about watershed awareness and the importance of an individual's behavior on the health of a watershed. Pollution prevention programs coupled with the water quality benefit of the stormwater retrofits should help meet the water quality goals of the Watts Branch watershed as well as the downstream receiving waters (i.e., the Potomac River and Chesapeake Bay). While these program recommendations are targeted for Watts Branch, they also have applicability throughout the City. In fact, it may be easier and more efficient for the City to initiate a city-wide campaign.

Table 5.2 Nonstructural Pollution Prevention Program Recommendations

Program Recommendation	Program Components
Watershed Awareness	• Promote general awareness and responsibility of citizens with respect to being good stewards to their watersheds • Encourage and promote citizen activities around watersheds such as monitoring, tree plantings, "green-up" days, water conservation, clean ups and policing (e.g., reporting illegal dumping)
Pet Waste Management	• Signage and waste disposal stations • Fact sheets and limited media campaign
Lawn and Garden Care, Landscaping (Bay Scapes)	• Promotion of soil testing through Montgomery College • Recognize citizens using proper practices • Garden club and nursery outreach and education
Automotive Care (Car Washing and Maintenance)	• Promotion of washing on pervious surfaces and with minimum amounts of water • Proper disposal and recycling of used motor fluids
Good Housekeeping	• Promotion of proper disposal and/or recycling of household and commercial hazardous wastes
Disconnection of Directly Connected Impervious Areas	• Institute downspout disconnection and rain barrel program
Illicit Connection Detection and Removal	• Monitor and eliminate illicit connections in targeted commercial areas
Commercial Dumpster Management	• Locate away from storm drain inlets and riparian buffers • Promote/require use of enclosed holding areas

The Center has prepared general guidance on components of a pollution prevention and public education program outside of the framework of this Watts Branch study. The recommendations and guidance are general enough so that they can be customized for the particular needs of different watersheds within the City of Rockville and even different neighborhoods within a given watershed.

5.5 Watershed Indicator Monitoring

Having a method to assess the efficacy of the implemented watershed restoration measures and a basis from which to recommend modifications to the plan is a critical piece to the overall plan. A goal of the Center's recommended watershed management plan approach is to utilize stormwater indicators to the maximum extent practical to guide current and future management decisions. The recommendations are oriented towards conducting inexpensive, repeatable, and scientifically valid monitoring to assess future stream quality health. The monitoring of indicators will provide a key frame of reference and basis for updating and adjusting the Watts Branch Watershed Management Plan.

Traditionally, the focus of monitoring efforts to assess the quality of receiving waters has been end-of-pipe chemical and physical water quality criteria and analysis. In the last decade, however, many stormwater management professionals have begun to question the ability of traditional monitoring to accurately describe existing conditions in receiving waters, evaluate the overall integrity of aquatic communities, and assess the degree of improvement in stream systems. Instead, there has been a steady shift towards the use of "environmental indicators" to more accurately assess the condition(s) of receiving waters and the performance of stormwater management efforts.

Environmental indicators, although based on diverse measurements, when examined in combination, give a general indication of improvements or downturns in the environment and the effectiveness of resource management strategies. "Stormwater indicators" specifically focus on urban stormwater runoff impacts and can be used to assess the success (or failure) of stormwater management efforts.

A suite of six indicators (Table 5.3) has been identified and recommended to assess the efficacy of the Watts Branch Watershed Management Plan. As part of this project, baseline macroinvertebrate and fish data will be collected during the spring and early summer of 2001. These data will provide a benchmark from which to measure various aspects of the proposed management plan. A general description of the sampling effort is provided below; however, a separate protocol document for the proposed sampling and analysis will be developed and submitted to the City prior to the start of the field work.

Table 5.3 Stormwater Indicator Profile Categories

Indicator Category	Indicator Name
Physical and Hydrological Indicators	• Stream widening/downcutting • Physical habitat monitoring
Biological Indicators	• Macroinvertebrate and fish assemblage
Social Indicators	• Public attitude surveys • Public involvement and monitoring • User perception

5.5.1 Recommended Watts Branch Stormwater Indicators

The indicators, organized into three categories, represent both traditional and less frequently used assessment methods. A total of six indicators (Table 5.3) have been identified and recommended for implementation to assess the efficacy of the Watts Branch Watershed Management Plan. Descriptions of each group of indicators are provided below. Using the findings of the various indicator monitoring, the Watts Branch Watershed Management Plan will need to be modified and updated to more effectively achieve the goals of the plan. The indicator monitoring also provides opportunities for public involvement, which helps foster the ongoing process of watershed awareness and behavior modification.

Physical and Hydrological Indicators

Phase I of this study both supplemented and continued Dr. Leopold's work on channel enlargement response to impervious cover by utilizing historical cross-sectional surveys, combined with current cross-sectional measurements. It is recommended that this effort be continued at all ten stations, with the monitoring schedule dependent upon the stormwater retrofit construction implementation and the development of the King Farm and Fallsgrove parcels. Establishing monumented cross-sections at some of the 10 stations would strengthen the existing data set and provide a more reliable and repeatable measure of channel degradation or aggradation in the future.

The two Leopold stations (WAT 7 & WAT 8) are proposed to be installed with permanent monuments to provide both a horizontal and vertical definition of the channel evolution versus watershed imperviousness over time. This information will be combined with the biological data to provide an interpretive watershed trend. The information can also be used as a qualitative assessment tool of hydrologic response as a result of upstream stormwater management. For example, if a station cross-section (which is downstream of stormwater retrofits where channel protection storage has been provided) remains largely unchanged over an extended period of time (say 10 years), then it might be fairly assumed that the upstream retrofit has had an arresting effect on the channel enlargement process.

While not mandatory, the City may want to pursue re-establishing the USGS stream gage on the mainstem of Watts Branch at the upstream boundary of Woottons Mill Park to help assess flow trends and evaluate the efficacy of the watershed-wide modeling performed under Section 2.3 and 3.5. In addition, this location would be an excellent site for interpretive signage to help with watershed awareness. Signage might include historic Leopold photographs, cross-section comparisons, and habitat and stream gage data data.

In addition to monitoring the channel morphology, physical habitat can easily be monitored using the repeatable RSAT approach. With a quantitative score previously established at approximately 400-foot intervals along the length of stream, this assessment provides a useful basis for comparison with past surveys. Repeating the assessment in ten years to document changes in the watershed condition is recommended.

Biological Indicators

The historical biological and water quality data record for the Watts Branch watershed is much more sporadic than the record for channel enlargement analysis and comes from a variety of sources with differing formats. The information ranges from field observations to water chemistry analyses from both government agencies and private consultants. It is therefore recommended that a uniform monitoring protocol be established to initially obtain an adequate baseline data set so that accurate water quality trends are defined. Biological indicators represent an environmentally based method for assessing water quality that is inexpensive, repeatable and scientifically valid.

An advantage of using this indicator on Watts Branch is that Montgomery County already has a well established biological monitoring program and protocol in place (i.e., Index of Biological Integrity (IBI)). In addition, the County has previously sampled macroinvertebrate and fish assemblages in Watts Branch (downstream of the City of Rockville), thereby providing an existing database from which to draw some inferences.

Biological monitoring (biomonitoring) techniques are best used for detecting aquatic ecosystem impairments and assessing their relative severity. Furthermore, biomonitoring is an important tool for evaluating the effectiveness of control measures such as stormwater management retrofits and stream rehabilitation practices. Some specific advantages of using biomonitoring for watershed plan monitoring are:

- Biological communities reflect overall ecological integrity (i.e., chemical, physical, and biological integrity).
- Biological communities integrate the effects of different stressors and thus provide a broad measure of their aggregate impact.
- Communities integrate the stresses over time and provide an ecological measure of fluctuating environmental conditions.
- Routine monitoring of biological communities can be relatively inexpensive, particularly when compared to the cost of assessing toxic pollutants, either chemically or with toxicity tests.
- The status of biological communities is of direct interest to the public as a measure of a pollution free environment.

Two different assemblage groups are typically used in biomonitoring surveys and are recommended for the Watts Branch indicator monitoring, namely, macroinvertebrates and fish. The advantages of each assemblage group are described below:

Advantages of using macroinvertebrates:

- Macroinvertebrate assemblages are good indicators of localized conditions. Because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life, they are particularly well-suited for assessing site-specific impacts (upstream-downstream studies).
- Macroinvertebrates integrate the effects of short-term environmental variations. Most species have a complex life cycle of approximately one year or more. Sensitive life stages will respond quickly to stress; the overall community will respond more slowly.
- Degraded conditions can often be detected by an experienced biologist with only a cursory examination of the benthic macroinvertebrate assemblage. Macroinvertebrates are relatively

easy to identify to family level, and many "intolerant" taxa can be identified to lower taxonomic levels with ease.
- Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects.
- Sampling is relatively easy, requires few people and inexpensive gear, and has minimal detrimental effect on the resident biota.
- Benthic macroinvertebrates serve as a primary food source for fish, including many recreationally important species.
- Benthic macroinvertebrates are abundant in most streams. Many small first and second order streams, which naturally support a diverse macroinvertebrate fauna, only support a limited fish fauna.

Advantages of using fish:

- Fish are good indicators of long-term (several years) effects and broad habitat conditions because they are relatively long-lived and mobile.
- Fish assemblages generally include a range of species that represent a variety of trophic levels (omnivores, herbivores, insectivores, planktivores, piscivores). They tend to integrate effects of lower trophic levels; thus, fish assemblage structure is reflective of integrated environmental health.
- Fish are relatively easy to collect (possibly by volunteer stakeholders) and identify to the species level. Most specimens can be sorted and identified in the field by experienced fisheries professionals, and subsequently released unharmed.
- Monitoring fish provides direct evaluation of “fishability” and “fish propagation”, which emphasizes the importance of fish to anglers, bringing the stakeholders to the watershed.

It is recommended that the general Montgomery County macroinvertebrate sampling protocol and IBI be conducted at the nine stream rehabilitation sites proposed for Watts Branch to generate a sound baseline data set with subsequent monitoring folded around the watershed plan implementation schedule. Use of the IBI will allow stream reaches in the Watts Branch watershed to be objectively rated based on a standard criteria and will allow for comparison to other streams within the region. However, it is important to note that once watershed imperviousness exceeds 20% (Watts Branch watershed imperviousness in approximately 28%), IBI scores tend to score in the fair or poor category. Even after stormwater management retrofits and stream restoration, many stream reaches may still score in the fair or poor category when assessed with the IBI. In order to detect finer scale changes, individual metrics will be analyzed prior to scoring. For instance, a stream prior to restoration may support only 4 or 5 taxa of macroinvertebrates. After restoration the same stream may support 8 or 9 taxa. Based upon the IBI scoring criteria, both of these results would receive a score of 1 for the Taxa Richness metric. The IBI would indicate no improvement based on the scoring, but the stream would be supporting twice as many taxa. Utilizing both the IBI and the individual metric results will allow for an accurate assessment of watershed restoration activities.

In addition, it is possible that the macroinvertebrate community may shift in response to the hydrologic and thermal influence associated with stormwater management controls (e.g., from a lentic make up to a lotic influenced make up). IBI’s have a bias towards rating these “lotic”

communities lower than lentic communities, and it is therefore important to be aware of this bias. This change in community make up should not necessarily be interpreted as a poorer condition of the stream, but instead should be evaluated in the context of the other indicators (e.g., physical and hydrological) and the fact that development in watersheds at levels comparable to Watts Branch will almost always result in a shift in the trophic status of the streams. For example, if the physical and hydrological indicators show that the habitat has improved and that channel enlargement has slowed, then a shift in the macroinvertebrate community is not necessarily an indication of declining stream health but rather a shift in trophic status as a consequence of watershed development and altered hydrologic regime.

A spring 2001 sampling period is proposed for the collection of a baseline data set. A separate protocol and "study design" document will be prepared prior to the monitoring period.

Social Indicators

While most social indicators have limited effectiveness due to their dynamic complexity and challenging goals, they are nevertheless critical indicators from the standpoint of educating and communicating with the public. Furthermore, social indicators are a necessity to increase local watershed awareness and expand it beyond Watts Branch.

Public attitude surveys are directed at targeted groups to assess general awareness of key water quality problems and willingness to finance (via government spending) restoration efforts. A targeted group is solicited with a direct mailout, an interview or other mechanism of communication to gather information regarding an existing or potential program. The results of a survey are usually compiled into a summary report which may, for example, indicate that the public believes urban runoff to be the most significant source of pollution in the watershed or that funding for restoration efforts should be increased. This information can then be used by decision makers in helping to formulate watershed management policy, develop restoration budgets and workplans, or implement stream restoration programs.

Public participation in stormwater programs is one measure of overall program effectiveness. Successful implementation of stormwater programs depends, in large part, upon the active support and participation of the public. Citizen monitoring programs, watershed stewardship groups, public education (including school curricula), participation in watershed education events (e.g., Earth Day, Watts Branch Trout Derby) are all components of public involvement programs. Other measures of public participation include participation in household hazardous waste recycling efforts, number of calls made to report illegal dumping into the storm sewer system or streams, and membership in citizen advisory groups.

Successful stormwater management efforts also depend on public support. Public support, in turn, depends upon its valuation of water resources. The public's valuation of a particular water body is usually based on more than water chemistry. Appearance, surroundings, ease of access, and apparent water quality are all considered by the average user. Being aware and understanding the public concerns and perceptions is an important, yet challenging, component in watershed restoration. Knowing who the staunchest advocates and critics are can go a long way towards being able to implement various programs and restoration measures.

The type and frequency of monitoring of public behavior and awareness can vary. Informal monitoring can occur by assessing attendance and interest at annual community functions and other environmental awareness initiatives. More formal resident surveys also have a role, and are recommended after about one year of the institution of a major public education campaign (e.g., pet waste and lawn care education). Questions in the survey should target whether the individuals are aware of the campaign, whether it has had impact on their behavior, and what recommendations they have to improve the message.

Monitoring social indicators directly ties into the public education and pollution prevention effort put forth by the City. A committed public education effort needs to incorporate follow-up surveys for the purposes of gaging the effectiveness of the program and to generate recommendations on how a program can be improved. The City already has an impressive community information and technology transfer infrastructure in place and can benefit from this network in terms of both the education goal and the response indicator assessment.

5.6 Implementation Schedule

Throughout the development of the Watts Branch Watershed Management Plan, the City of Rockville Department of Public Works has been evaluating and planning an implementation schedule for the priority projects. This planning has included budget considerations for the Capital Improvement Projects (CIP) list, need for other work in the Watts Branch stream valley such as sewer line rehabilitation, and concurrent scheduling for improvements approved in the Cabin John and Rock Creek watershed studies. Based on current budget planning and projections, the recommended projects which are City-owned or operated are slated for a staggered implementation over the next 10-year period. See Table 5.4 for the Watts Branch CIP Implementation Schedule. The City has started, and will continue to work with owners of private sites where watershed improvements have been recommended to facilitate those projects through the normal development process, environmental grant or public agency programs.

In light of the findings from this study, it is worth discussing the potential benefits of constructing 14 retrofit projects and nine stream rehabilitation sites on stream channel erosion and water quality. The total drainage area to be controlled by the 14 proposed retrofit sites will be approximately 1000 acres (see Table 3.5). Adding the drainage area being managed by the King Farm and those facilities proposed for the Fallsgrove, the total watershed area that can ultimately be managed by either an effective new stormwater practice or a retrofit is approximately 2020 acres or 3.2 square miles. Since the cumulative drainage area of Watts Branch within the City is approximately 6.5 square miles, it is realistic to assume that approximately 49% of the watershed will ultimately drain to an effective stormwater management facility. The nine stream rehabilitation sites have a total length of approximately 8,160 linear feet which is approximately 56 % of the total length of eroding stream identified through the RSAT inventory. Implementation of these retrofit and stream rehabilitation measures should result in significant reduction in pollutant load and help mitigate the continued channel enlargement process. The exact amount of pollutant load reduction and channel erosion mitigation will depend on the ultimate design configurations of the stormwater retrofits and stream rehabilitation sites, as well as the number of sites that are ultimately constructed.

Table 5.4 Watts Branch Capital Improvement Project (CIP) Implementation Schedule

WATTS BRANCH WATERSHED STUDY PROJECTS PROPOSED CIP IMPLEMENTATION SCHEDULE FY2002-2012											
WATTS BRANCH PROJECTS	**FY2002**	**FY2003**	**FY2004**	**FY2005**	**FY2006**	**FY2007**	**FY2008**	**FY2009**	**FY2010**	**FY2011**	**FY2012**
SM18 & SM20 (270 Industrial Park & Carnation Drive Ponds) & 204-5	***$81,000***		$259,000								
205-1 to 2, 204-1, 302-12; 205-5 to 8 (Upper Watts Br. Park Streamwork)					***$80,000***		$256,800				
SM23 (College Gardens Park Pond)			***$50,000***		$198,000						
O3 (Welsh Park Pond)				***$40,000***		$133,000					
302-3 to 4, 302-6, 302-8; 115A-1 to 3 (Woodley Gardens Park Streamwork)			***$70,000***		$193,000						
401-15 to 18, 103-1 to 2 (Woottons Mill Park-Upper Streamwork)	***$60,000***		$166,000								
401-8 to 11(Woottons Mill Park-Rockshire Streamwork)		***$40,000***		$110,000							
401-2 to 3, 401-5 to 6 (Woottons Mill Park-Lower Streamwork)									***$40,000***		$110,000
SM1, SM2 & SM3 (Horizon Hill Park Ponds)					***$88,000***		$293,000				
SM9 (Lakewood Country Club Pond)									***$10,000***		$35,000
SD8 & 103-5 to 8 (Glenora Park Pond & streamwork)							***$76,000***		$240,000		
301-2 to 4 (Woottons Mill Park-Rt. 28 trib streamwork)							***$30,000***		$83,000		
TOTAL YEARLY COSTS	**$141,000**	**$40,000**	**$545,000**	**$150,000**	**$559,000**	**$133,000**	**$655,800**	**$0**	**$373,000**	**$0**	**$145,000**

WATTS BRANCH GRAND TOTAL = $2,741,800

Bold italicized entries are design costs, regular entries are construction costs